

Central State University Combined Research and Extension Plan of Work 2021-2025

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I. Plan Overview

1. Executive Summary

Executive Summary

Central State University (CSU), the only state assisted Historically Black College and University (HBCU) in Ohio, is a residential, co-educational institution located in Wilberforce, 20 miles east of Dayton, Ohio. Central State was designated as an 1890 Land-Grant Institution on February 7, 2014. Over the past years, the University has aligned its mission with the mission of the Land-Grant legislation and has transformed the previous College of Science and Engineering into the College of Engineering, Science, Technology and Agriculture (CESTA) to provide educational opportunities to the general population, and to enhance its teaching, research and extension activities to solidify its Land-Grant status. CSU also has established a program in Agricultural Education to prepare teachers who can educate and prepare K-12 students for careers in agriculture. Dr. Cynthia Jackson-Hammond, CSU's President, is committed to the Land-Grant mission and vision, and is guiding the institutional efforts statewide and beyond. She is retiring from the University by this academic year and CSU has announced recently that Dr. Jack Thomas will become the new President of the University from July 1st, 2020. The State of Ohio is supporting CSU's Land-Grant mission with 100% match for the Evans-Allen Research, Cooperative Extension and the McIntire- Stennis programs. Dr. Alton B. Johnson serves as the Dean of CESTA and the Director of CSU's 1890 Land-Grant Programs and has the oversight of all Land-Grant Programs and the related linkages with The Ohio State University, the other Land-Grant Institution in the State of Ohio. The CSU Land-Grant Program is guided by the CSU Land-Grant Advisory Council (LGAC). The LGAC consists of 12 regular members and 2 Ex-Officio members and represents a cross-section of stakeholders from Ohio. Members come from the Ohio Farm Bureau, Ohio Farmers Union, Ohio Agribusiness Association, Natural Resources Conservation Service of USDA, commodity groups, a technology company, farmers and an agricultural vocational institution from the area. The composition of the LGAC is expected to be dynamic as we expand the horizons of our 1890 Land-Grant Mission.

The necessary administrative structures for operating the Land-Grant Programs have been set in place. Dr. Subramania I. Sriharan serves as the Associate Director of Research and Dr. Siddhartha Dasgupta serves as the Associate Extension Administrator. CSU is expected to get additional funding for its Evans-Allen and Cooperative Extension Programs through the application of appropriate formulas for the capacity allocations. This will essentially enable CSU to expand its research and extension programs and to serve the State of Ohio with appropriate programs focusing on critical issues affecting the State and the Nation.

CSU is expected to obtain enhanced levels of Federal support for its Evans-Allen and Cooperative Extension Programs from the newly enacted Farm Bill of 2018 compared to the level of funding for 2016-2018. The State of Ohio has been providing 100% matching funds, and it is expected this pattern will continue in the future. This would enable CSU to engage in expanded sets of activities for research and extension. CSU has not been engaged in farm research but will start farm research and assist the Cooperative Extension Program (CSU CEP). CSU CEP will assist farmers by guiding them on alternate crops, specialty crops including horticultural crops, aquaponics/hydroponics, bee keeping, soil health, and in sustainable agriculture, while maintaining the integrity of the agricultural eco systems. CSU CEP is expanding its service by creating four multi-county regions in Ohio in the southwest, southeast, northwest, and northeast corners of the state. These regions, in addition to CSU's presence in central Ohio would expand CSU CEP service counties to cover most of the state. CSU will take a systems approach as it engages in work ahead to serve the State of Ohio and the Nation. The systems approach will place emphasis on small and under-represented farmers, as well as other stakeholders in the State of Ohio. The knowledge gained by CSU will be shared with the U. S. and other nations globally. The systems will include (i) Plant Systems; (ii) Animal Systems; (iii) Food Nutrition and Health Systems; (iv) Natural Resources and Environmental Systems; and (v) Social and Allied Systems. The details of the issues addressed for each of the

systems is described below.

i. Plant Systems: Issues to be addressed under plant systems include Establishment of Alternative Crops, Increased Use of Natural Products, Modification of Plant Chemistry, Development of Rapid Metabolite Quantification Systems, and Natural Plant Products Research. CSU will engage in also the associated pollinator issues. Work related to addressing the pollinator issues is described under the section on Natural Plant Products Research. Growers in Ohio and across the US face low crop prices and struggle to keep their farms solvent. The overproduction of major grain crops (corn, soybeans, and wheat) by US farmers suppresses commodity prices. Farmers can be benefited by newer varieties of corn that have special food values.

Alternative crops are needed to provide growers new revenue streams. Moreover, large-scale adoption of alternative crops can reduce overproduction of major crops, thereby increasing commodity prices. Hemp, Cannabis sativa with a Δ^9 -tetrahydrocannabinol (THC) content less than 0.3%, can be utilized as a food, fiber, feed, bioenergy, and medicine. It is first necessary to explore and develop natural products from plants to provide knowledge and help establish valuable niche markets for alternative and specialty crops. Interesting candidates for Ohio include amaranth, sweet potato, high-amylose corn, tree fruit and nut crops, medicinal plants, hemp, and hops. In particular, high-amylose corn, is of interest. Corn is one of the most diverse grain crops whereby many variations exist through evolution and extensive breeding efforts. The special variety known as high-amylose corn, has amylose content in the starch is above normal levels. Recent developments have increased the status of high-amylose corn, particularly the concentration on bioplastics and the search by food companies for a starch type that resists digestion. As a food ingredient, consumers could benefit from high-amylose starch because it has a lower glycemic index than other starches. We have engaged a scientist to research into breeding and developing appropriate high-amylose corn varieties that are suited to Midwestern climate zones. We are proposing to engage additional scientist who can assist in breeding and commercializing newer varieties of corn including high-amylose corn.

Establishment of Alternative Crops: Growers in Ohio and across the US face low crop prices and struggle to keep their farms solvent. The overproduction of major grain crops (corn, soybeans, and wheat) by US farmers suppresses commodity prices. Alternative crops are needed to provide growers new revenue streams. Moreover, large-scale adoption of alternative crops can reduce overproduction of major crops, thereby increasing commodity prices. Hemp, Cannabis sativa with a Δ^9 -tetrahydrocannabinol (THC) content less than 0.3%, can be utilized as a food, fiber, feed, bioenergy, and medicine. Currently, hemp commands premium grain and metabolite prices, driving droves of farmers to grow this crop. However, a number of challenges remain with hemp production. Basic agronomic production practices and improved understanding of plant chemistry need to be developed. Due to the rapidly expanding craft beer industry, hops (*Humulus lupulus*) may also serve as an alternative income source for farmers. To date, hops production is limited by the high set-up cost, management of tall plants, and post-harvest processing expenses.

Increase Use of Natural Products: Plant-derived natural products typically earn superior prices at market due to their difficulty of crop production, limited availability, and challenges of extraction. At present, difficulties with the process of extracting and purifying compounds on a large scale severely restricts the use of plants for production of natural products. Erasing processing challenges will allow companies to expand their use of plant-derived natural products. An increased market demand will provide cultivators of alternative high-value crops to produce. Importantly, the rapid development of the hemp industry across the US has brought on-line a number of extraction facilities. The existing extraction technology can generate a range of crude multi-metabolite extracts to fully purified single compounds. Hemp-derived cannabinoids are being extracted and isolated on a large scale, to supply the herbal supplement market. Expanding the use of hemp extracts and cannabinoids beyond medical applications could further increase the demand for such products. Isolation of natural products offers the opportunity, not only for farmers to have alternative profitable crops, but may reduce US dependence upon oil-based synthesis of key industrial compounds.

Modification of Plant Chemistry: Plants are nature's pharmacy, synthesizing an estimated 200,000 to 1 million metabolites. Each plant produces hundreds of natural products, some of which are species-specific or only found within a few close relatives. These compounds serve as nutrients, spices, fragrances, pesticides, medicines, industrial compounds, and scaffolds for pharmaceutical development. Plants synthesis these compounds for their defense to abiotic and biotic stress. However; to animals or humans, the presence of some natural products may be beneficial whereas others are detrimental. Modification to plant chemistry provides opportunities to improve the nutritional content and safety of foods. Platforms for stable and transient genetic modification of hemp are being developed to further our ability to redirect natural product biosynthesis toward targeted metabolites. These systems will also allow identification of genetic factors underlying hemp

natural product biosynthesis and accumulation. Our other efforts in modification of plant chemistry seek to maximize the use of plant-derived natural products. During some extraction processes, low-value, toxic, or otherwise undesired by-products may be generated. We are evaluating methods to modify extraction by-products into high-value compounds of agricultural, industrial, or medical interest.

Development of Rapid Metabolite Quantification Systems: Synthesis of natural products in plants responds to a number of developmental and environmental cues. Moreover, the abundance of natural products within a plant requires sophisticated methods to distinguish and quantify each metabolite. We plan to develop simple and robust tools for on-farm quantification of key metabolites. The systems will be a cost-effective, disposable, user-friendly, hand-held device that tests samples within minutes. Rapid metabolite quantification technology will also improve plant breeders' ability to develop new varieties with desired natural product profiles.

Natural Plant Products Research: Agricultural systems in Ohio are overwhelmingly dominated by two crops: corn and soybeans. Small farms in the State, which traditionally have made a living from dairy and vegetables, have been struggling for years and are steadily disappearing. Both large and small farmers alike need alternative crops, which are lucrative, to diversify production, reduce risk exposure and increase profitability. Growing a diverse selection of crops can expand market access for farmers and help offset commodity price swings and financial uncertainty. Strategic diversification improves the overall economic picture for small farmers, however support is required to prospect alternative crops. For example, former tobacco farmers in Kentucky are profiting by producing sweet potato, grossing up to \$7000 per acre, due to research supported from local institutions of higher learning. Meanwhile, there is an increasing trend among the population nationwide to use alternative medicine and products based on biological ingredients. According to the NIH, over 50 plants have proven medicinal properties, some of which are already available as dietary supplements. However, the sources for the plant materials remains heavily foreign-based, and sound research into cultivation and extraction methods is deficient. Likewise, small to medium enterprises requiring high-quality raw materials for natural products are becoming more numerous. Thus, research and extension to advance local farmers to cultivate high-quality plant materials for use in product formulations is rather timely. Natural products from plants, venom, animals, fungi and bacteria are in high demand as sources of biochemical diversity for medicinal, herbal and industrial formulations. New and novel biochemical research is needed to combat disease, allergies and microbial resistance to antibiotics, as well as to provide energy and constitute the basis for everyday consumable products. Chemicals from a variety of natural sources may serve as safe and effective alternatives to synthesized drugs with fewer side effects and petrol-based resources. These natural compounds also may be better accepted by diverse populations with different ethnic backgrounds. The success of bio-products, including biofuels, biopolymers, bio-detergents and biocosmetics, requires a broad range of economical materials available for formulation. The potential of plant and phytochemicals for use in food and non-food products can be employed for growth and increase production to enhance economic viability of small rural agricultural-based communities. It is first necessary to explore and develop natural products from plants to provide knowledge and help establish valuable niche markets for alternative and specialty crops. Interesting candidates for Ohio include amaranth, sweet potato, high-amylose corn, tree fruit and nut crops, medicinal plants, hemp, and hops. In particular, high-amylose corn, is of interest. Corn is one of the most diverse grain crops, whereby many variations exist through evolution and extensive breeding efforts. Corn is also the largest crop in the United States, which produces over 7 billion bushels of dent corn per year. Processed corn products are diverse, including cooking oil and various corn chips, grits, meals, flours, and starches. Corn starches can be processed further into a variety of food and industrial products, including fat substitutes, sweeteners, alcohol, paper, adhesives, paints, soaps, and cosmetics among a wide assortment of others. Although most of these products are made from dent corn, other types of corn are gaining importance as the industry focuses on niche markets and competitive advantages for specialty corns. One such variety is known as high-amylose corn, where the amylose content in the starch is above normal levels. Recent developments have increased the status of high-amylose corn, particularly the concentration on bioplastics and the search by food companies for a starch type that resists digestion. As a food ingredient, consumers could benefit from high-amylose starch because it has a lower glycemic index than other starches. The research at CSU will focus on this specific commodity concerning production and processing practices for supporting regional growers and industry. A partnership is being established in which high-amylose corn will be promoted to a network of more than 100 growers in southwestern Ohio. Producers will receive a premium price for their harvest and the resources to handle and market the harvest are in progress. CSU will play a crucial role in supporting research and development of this valuable commodity for local stakeholders. The successful implementation of natural product economy and production of alternative crops in agriculture demands interdisciplinary and integrated approaches to address relevant issues that are interrelated to agricultural production and community planning and development. The science and applications involving sustainable plant and animal systems must integrate biology, chemistry, agronomy, and economics.

Academia must be a force to produce and disseminate knowledge of process biological products (such as food, feed, fiber, medicinal herbs, new agricultural products and biofuel), while promoting conservation of natural resources, preserving environmental quality, and ensuring the health and safety of people. We plan to develop a farm research center in the lands around the campus and engage in related research. Experimental plots in individual farms around CSU will also be planned and related studies will be conducted.

CSU CEP will have a direct partnership with the plant systems research program under ARDP at CSU. Research projects deemed to have a direct application to Ohio's farmers, in both rural and urban settings, will have some of their results disseminated using CSU CEP resources and programs. Some of this dissemination will occur through production and marketing demonstrations, and will include conventional and organic vegetable production, hydroponics, aquaponics, hemp, and high amylase corn demonstrations and associated farmer-training workshops. Soil less production systems such as hydroponics and aquaponics will be an important element to support limited-resource and small farms, farms with marginal land and farms with challenges in land/capital/labor access. CSU will conduct both research and extension programs in soilless culture. Some of these projects that show significant promise for limited-resource and small farms will be adopted into the training curriculum of prospective and beginning farmers by CSU CEP.

Forestry Research and Extension Research: Forestry systems are a priority area for CSU CEP. CSU CEP staff are stationed in Southeastern Ohio, in Appalachian counties, to provide outreach in forestry-related issues. Forestry programming will address the following needs: 1) educate youth and underserved communities in southeast Ohio about forestry issues that are impacting their communities, 2) develop outreach programs that are collaborative with Ohio's Interagency Forestry Team which involves multiple governmental (e.g., U. S. Forest Service) and Land Grant institutional (e.g., The Ohio State University) partners, and 3) increase the role of CSU's 1890 Land Grant program in forestry issues of Ohio.

ii. Animal Systems Research Program: Avian Systems: Ohio is one of the largest egg farming states in the Nation. Egg, chicken and turkey farms in Ohio create more than 20,586 jobs annually generating \$718 million to the state's economy. Ohio farmers require assistance in all aspects of poultry production, including related food safety issues; it is critical to provide field-based diagnostic services to the poultry industry, producers, aviculturists, veterinarians and governmental agencies of Ohio. CSU has to perform appropriate examinations, interpret history and laboratory tests, and visit farms, hatcheries, processing plants and other avian enterprises to diagnose, report and formulate prevention and control plans for spontaneously-occurring diseases of poultry and a variety of other avian species. One of the long term goals of the University is to re-establish an animal science/poultry science research program. CSU intends to explore animal and poultry research and extension programs that will potentially benefit limited-resource and small farms in Ohio. We plan to collaborate with farmers in the area who have animal operations and engage in research towards animal health and food safety.

iii. Food and Nutrition and Health Systems (FNH): The health of an individual and the overall population encompasses many factors: behavioral, economic, environmental, educational, and genetics. Diet and nutrition are important to overall health, particularly through the environmental factor. Excessive weight and obesity, sedentary lifestyles, iron deficiency, food insecurity related to socioeconomic factors, and other disease states are major dietary health concerns in the US. Nutrition and exercise education and programming, and food delivery systems to underserved populations in order to target treatments are necessary for Research and Extension to undertake. CSU needs to determine the best practices in health promotion. The US spends \$200 billion in health care related to obesity and more than 81 million Americans are completely inactive and lack physical activity. Ohio has the 11th highest adult obesity rate in the nation, and the sixth highest obesity rate for youth ages 10 to 17. It is critical to conduct research on nutritional diet and exercise based on nutrigenomics knowledge. It is necessary to develop personalized nutrition plans, based on Nutrigenomics and research into relaxation techniques using Yoga and integrate the nutrigenomics with the use of herbs. Extensive physiological studies of physical fitness and disease prevention, especially as it relates to obesity, hypertension, and type II diabetes in minority populations, are needed. Obesity in children is a growing epidemic in the United States, and the minority populations are especially at risk for obesity. Physiologic parameters including resting heart rate, blood pressure and body composition will need to be assessed before and after the intervention. Studies will focus on reduction of obesity and diabetes prevention in African Americans and other minority groups. It is also necessary to conduct fat composition analysis studies in adult minority population. CSU will also focus on Exercise for Individuals with Special Needs. Individuals with special needs face barriers to participation in exercise and physical activities, which can adversely affect

their health and quality of life. One of the common barriers is insufficient knowledge of exercise professionals on how to adapt “typical” exercise programs or to make accommodations to provide access to exercise equipment. The significance of this effort is that it could provide evidence of the effects of personalized exercise programs on independence and quality of life. With positive evidence, more individuals with special needs may pursue opportunities to participate in an active lifestyle. Nutrition for Individuals with Special Needs and individuals with chronic diseases and/or disabilities tend to have specific nutritional concerns such as reduced sodium intake, gluten free diet, heart-healthy diet, etc. The first step is nutritional knowledge. Unfortunately, nutrition knowledge does not always translate to better nutritional intake. We are proposing to re-structure our efforts towards the FNH systems as we move forward. We have been systematically building our capacity in the fields of Food, Nutrition and Health (FNH). CESTA has been constantly assessing itself to align the needs with expertise available and cost of building capacity. Over these short years it has been focusing on nutrition, exercise and control of diabetes. We have also been exploring to engage in nutrigenomics research. With additional funding through capacity formulas, CESTA is now planning to add new capabilities in food science related extension and research services. Nutrigenomics research requires extensive laboratory work and appropriate spaces and support staff for setting up such facilities are currently not available at CESTA. In view of these constraints we reevaluated the current structure of the research objectives and revised the FNH efforts to include food science related research. We are placing focus on this area of research by proposing to adding a food scientist to the FNH. Expertise in the area of food science for research and extension is an urgent need and we can develop synergistic programs with the research on Natural Products described previously.

CSU CEP would be involved statewide training of food, nutrition, exercise, and disease mitigation through its Family and Consumer Science/EFNEP program. With aid of a mobile kitchen, CSU CEP educators can take healthful cooking and disease mitigation programming statewide.

Summary of Proposed Efforts under Restructuring FNH

The health of an individual as well as the health of communities are affected by many things. Behavioral aspects for an individual are related to their choices such as what they eat, how much they move, whether they smoke or drink to excess. One of the goals of the Food, Nutrition, and Health project is to figure out ways to decrease the differences in the health of individuals in rural and underserved communities. Given the health benefits of unprocessed fruits and vegetables, lean meats and dairy products, along with regular physical activity, finding ways to provide access to educational materials and social support will go a long way to improving the health of communities as well as individuals. This research will look primarily at new sources of nutrients, different methods of safe production of food, different ways of delivering education on nutrition and foods, and providing exercise programs by different methods. Our major goal is to have a positive effect on the health of rural and underserved communities through the development of wellness programs through cooperative research. Expected outcomes include (1) figuring out new food production and storage methods to help provide a sustainable food supply that can be accessed by everyone, (2) recommending exercise and ways to become more physically active for those individuals who cannot access typical methods such as fitness centers or personal trainers, (3) figure out cost effective and motivational educational products that rural individuals can tap into to help their understanding of health and what they can do to improve theirs, (4) develop a place within this area that can be available for those individuals to come for personal nutrition and exercise guidance. This will include assessing overall health, and providing guidance either in person, over the phone, or electronically.

Goal 1: New foods are being introduced into our food supply daily. Agriculture researchers are looking for ways to increase financial benefits to producers and nutrient content for consumers. Examples include hemp, sea vegetables, and bee pollen. This work will look at how processing affects food safety and nutrient content and determine better ways to produce healthier food which lasts longer with the intention of providing healthier food to rural and underserved communities.

Goal 2: Individuals with chronic diseases or developmental issues tend to be less physically active than typical individuals. This can have long term effects on their overall health and ability to live independently. This project will work on ways to maintain or decrease symptoms that occur in chronic diseases such as multiple sclerosis or autism. It will also look at how exercise can be used to get individuals with developmental diseases involved in their communities either through work or volunteering, and also to keep them as independent as possible for as long as possible.

Goal 3: Research has shown that individuals with chronic diseases, and those at risk for chronic diseases, lack understanding of what constitutes healthy eating and safe physical activity recommendations. Many programs can show

an increase in understanding of healthy lifestyles but few show long term changes occurring. This project will work on determining the methods of giving information to individuals which will produce actual change in behaviors. While this will be different for everyone, understanding what makes individuals change their behaviors will help lead to better programs.

Goal 4: Food safety research will be in the area of applied and/or fundamental food microbiology and food safety. This project will evaluate methods of food production, food transport, and other aspects affecting the safety of our food supply.

Goal 5: Individuals in rural communities often travel great distances to health and fitness professionals to obtain assessment and guidance on health behaviors. This project will set up a health and fitness evaluation center which will be available to individuals in the surrounding rural community to obtain assessments of health parameters and guidance from trained health and fitness professionals. This center will also be available for those underserved populations who may not be able to pay for this type of service from for profit centers. This is an attempt to help reduce the amount of health inequity that exists in rural communities and underserved populations.

In summary, the food, nutrition, and health group is trying to affect healthy change within communities by determining methods of providing healthy food, health information, and physical activity guidelines in ways that will promote long term behavior change.

CSU CEP will continue to partner with CSU's Food and Nutrition and Health Systems researchers in ARDP to provide up to date research-based information to our stakeholders all over Ohio. It is no secret that there is a direct correlation between poverty and poor nutrition. To support our 1890 Land Grant mission, CSU CEP will continue to provide Diabetes Empowerment Education Program (DEEP) to our minority, socially disadvantaged, and economically depressed stakeholders, hold demonstrations in incorporating more vegetables and fruits in their diets, and provide exercise options that can be done at home with no specialized equipment that are easy on time demands of busy adults. In addition, CSU CEP 4-H program and ANR program will partner to jointly train children, youth, and families at risk (CYFAR) about healthy eating on a budget, inexpensive production of vegetables, fruits, and herbs for at-home consumption, and provide opportunities for safe and engaging physical activities for the youth, through after school programs and summer programs.

iv. Natural Resources and Environmental Systems: We propose to address a wide-variety of issues related to agricultural natural resources and the associated environmental systems. These resources include soil, water, natural species in soil, water and air that are part of the agricultural eco system. Environmental systems comprising air, water and soil have to be monitored and managed so that sustainability of agriculture is enhanced.

Pollinator Issues: Honeybees are the most important managed pollinators, contributing \$15 billion for the US economy. The honeybee colonies are in a 40-50% decline in the country. In particular, managed bee colonies are in a 60% annual decline in Ohio. Promoting mite resistant bees is one of the most effective ways to mitigate the bee decline. It is imperative that we develop new methods for increasing genetic diversity and to improve queen bee quality. The limiting factors affecting local honey bee resources include fewer queens and the nuclei available to fulfill the demand of beekeepers in the region. Since the establishment of a honeybee research program by Dr. Hongmei Li-Byarlay in the ARDP, CSU has become a leading institution of pollinator research in Ohio and in the region. We are collaborating with regional institutions, area bee keepers and also with international organizations to study a variety of research topics related to pollinator health and sustainability. Mobile bee labs and flight cages are being planned to be installed in the lands owned by CSU to study pollinator health and for exploring ways to expand a healthy queen bee population in the region.

Water Resources and Water Quality: Water issues in US are related to 1) variability in availability of the resource for agriculture, domestic, industrial and commercial uses, firefighting and recreation; 2) floods and droughts; 3) water quality; 4) economics of water resources and 5) ways for energy generation. CSU has the capacity for modeling hydraulic and water resources systems and plans to expand its capabilities in precision agriculture, geo-spatial applications in agricultural water resources, eco hydraulics and aquatic microbiology. We will also engage in water modeling and control technologies. The major phenomenon of change in climate impacts all aspects of water, which requires planning structural and non-structural measures. A major water issue in Ohio is related to water quality. Nitrogen and Phosphorus in agricultural runoff and leaching continues to be a non-point source pollution affecting water quality in Ohio watersheds by causing harmful algal blooms. So far, little research has been done in cropped acres of southwestern Ohio to quantify the impact of nutrient pollution on water quality. We intend to assess the effectiveness of several agricultural best management practices in reducing nutrient loads in the Great and Little Miami watersheds that drain into the Ohio River, and subsequently, into the Mississippi River and Gulf of Mexico. We expect to achieve the result by utilizing advance

geospatial technologies, coupled with on-farm research. While water quality related to agricultural runoff is important, water distribution and wastewater management in municipal areas have to be focused to serve people for an enhanced quality of life at optimal cost. The water resources issues including the water quality issues will be addressed by strengthening the International Center for Water Resources Management (ICWRM) in CESTA at CSU. The ICWRM is currently engaged in assessing the water quality in the streams and farms in the Appalachian areas of Ohio in the application of Smart Water Technologies for the Montgomery County Environmental Services (MCES). The ICWRM has advanced water quality instrumentation, excellent hydraulics/hydrology instrumentation and a remote sensing laboratory.

The remote sensing laboratory has licenses to advanced legacy software, spectra-radiometers and advanced GPS units for groundtruthing work. Issues that will be taken up for research will include, but are not limited to : Variability in the effectiveness of best management practices in nutrient pollution control: Besides, Great Miami and Little Miami Watersheds, research on the impact of various agricultural best management practices on nutrient Loading in the Maumee River basin in the Northwestern Ohio is also critical. Specifically, field scale interactions between nutrients, soil types and management is crucial for improved understanding of the effectiveness these practices on nutrient load reductions. Research in this area would enable comparisons between the water quality stressors in northwestern and southwestern Ohio watersheds, which would in turn be helpful in guiding policy decisions.

Smart Sensors for Monitoring and Control of Combined Sewer Overflows: ICWRM will engage in developing smart sensors to minimize infiltration and inflow in sewer systems under extreme rainfall. The research is being piloted by the Montgomery County Environmental Services for the sewer systems for the City of Dayton service area. The primary efforts of this partnership, related to wastewater, are flow monitoring and wastewater sampling. Flow monitoring using georeferenced real-time sensors provides Montgomery County with information that can be used for the creation of a sanitary sewer model which can serve as a decision making tool and aid in supervisory control of water and sewer systems by through acquiring the health and integrity of the network through monitoring at strategic locations using sensors. The data can also be analyzed to quantify inflow and infiltration in the wastewater system and how it responds to rainfall in general and also to critical storm events. This information can be used in conjunction to wastewater sampling data to better understand nutrient loads in the sanitary system, where they are coming from, and how effectively they can be mitigated. This information is valuable to understanding the nutrient loads into the Great Miami River, Ohio and proper accounting for the nutrient runoff from the municipal discharges (storm water and sewage) into the watershed.

Smart Water Distribution Systems for emerging chemical threat identification with Real-time sensors: The collaborative work by Central State and Montgomery County involves installing pressure sensors on fire hydrants to collect data for calibrating the water distribution model. The calibrated model can be used to identify issues in the water system such as aging of the pipes, pressure losses, possible leaks, residual chlorine and other emerging chemicals within the network, capacity testing using automated fire flow analysis, and as a decision making tool for future expansions of the distribution network to increase the overall health of the water system. The tool will be innovatively used as a threat detection and response system for isolation of emerging chemicals such as PFAS. Research on possible removal of PFAS using GAC and anion exchange resins will be attempted in ICWRM labs using pilot scale feasibility studies for applications in small to medium scale drinking water treatment systems.

Renewable Energy: The ICWRM has unique capabilities in hydropower research. Studies have indicated there are more than 50,000 unpowered small dams and other hydraulic drops available in irrigation systems in the US. Technologies to develop hydropower units for the unpowered dams and other hydraulic drops can enhance the contribution from renewable sources for isolated communities and other stakeholders. We will engage in developing appropriate technologies towards generating small hydropower units.

Agricultural Water Quality: Nitrogen and Phosphorus in agricultural runoff and leaching continues to be a non-point source pollution affecting water quality in Ohio watersheds by causing harmful algal blooms. So far, little research has been done in cropped acres of southwestern Ohio to quantify the impact of nutrient pollution on water quality. We intend to assess the effectiveness of several agricultural best management practices in reducing nutrient loads in the Great and Little Miami watersheds that drain into the Ohio River and subsequently into the Mississippi river and Gulf of Mexico. We expect to achieve this by utilizing advance geospatial technologies coupled with on farm research. With the aim of increasing informed adoption of sustainable agricultural practices and diversifying cropping systems, Central State University, envisions to achieve the following : Quantifying the efficacy of agricultural best management practices that promote row

crop agriculture while mitigating non-point source nutrient pollution; Utilizing proximal, drone-based and satellite sensing and advanced data mining techniques for precision soil and crop management; Developing precision water management strategies for specialty crops in small farm agriculture; Using geospatial technology and hydrologic modeling to map water fluxes, and fate and transport of harmful environmental chemicals; Spatio-temporal modeling of biospheric- atmospheric interactions, to understand vegetation water stress, human withdrawals of water from surface and subsurface reservoirs; and Study microbial interaction in agricultural runoff, streams, lakes and other water systems with other biota and abiota. We expect to achieve these goals by integrating expertise from various related disciplines and adopting a systems approach.

Soil Information and Health: A critical component of plant productivity and environmental quality in agricultural systems is the concept of "soil security." To effectively manage water resources, informed management of soil resources is imperative. An assessment of soil information and health at local, regional and global scales will provide a holistic system-based approach to address the issues at the nexus of plant, animal, natural resources and environmental systems. We expect to utilize advanced machine learning and geospatial techniques to carry out this assessment at varying spatial scales and study the impact of agricultural best management practices on soil resources, crop productivity and environmental quality.

Agricultural Ecology: Biodiversity and saving endangered species are important for improving the ecosystems in farming areas. Organic farming has numerous benefits in improving the ecosystems. The agro-eco systems involve land, water and the biota. Farming and other activities in agricultural areas have to be conducted with sustainability goals. Organic farming is claimed to have numerous benefits in improving the ecosystems in agricultural areas. Biodiversity and saving endangered species are important for improving the ecosystems in farming areas.

CSU CEP will continue to partner with CSU Agricultural Research Development Program (ARDP) to provide recent research-based information through workshops and internet-based videos and presentations to our stakeholders. In this, CSU CEP will develop its website, Facebook, YouTube, and Instagram outlets as a means of accomplishing the dissemination of results from Evans-Allen research. These outlets will contain presentations, fact sheets, and/or videos regarding beehive management, precision agriculture, proper pesticide handling and applications, and mitigation of agricultural nutrient runoffs in Ohio's watersheds.

v) **Social and Allied Research Systems :** The Development of Better Social Economic Sustainable Communities program is formulated with a unifying goal to provide resource planning and economic development leadership to help farmers and urban communities better solve problems and address financial and economic issues. This planned program outlines measures that will be implemented in Ohio communities. The knowledge areas (KA's) that drive the plan are centered on (1) making better family economic decisions; (2) improving resource availability; (3) increased community planning and development activities; and (4) better control of animal reproductive performance. .CSU CEP and ARDP will take an interdisciplinary and integrated approach to address relevant issues that are interrelated to agricultural production and community planning and development. This program intends to take an interdisciplinary and integrated approach to address relevant issues that are interrelated to agricultural production and community planning and development. It is no secret that there is a direct correlation between poverty and poor nutrition. This plan involves collaboration with other partner institutions, NGOs, city governments, businesses, federal agencies, policymakers and communities. Specific areas of our planned program include, but are not limited to, the following: explaining the economics and environmental impacts of renewable energy production and consumption; farm productivity and resource utilization efficiency; market analysis; community leadership, planning, and development; rural finance; needs of under-represented farmers/producers with limited resources; analysis of institutional and infrastructural constraints; strengths and challenges of local communities; and providing international trade-related educational programs, including trade shows, trade assistance, and consulting services. Another priority research area is conducting economic impact analyses and evaluating drivers of local economies.

The 2021-2025 planned program will involve the Agricultural Research Development Program (ARDP) and Cooperative Extension Program (CEP), including education programs that will strengthen the capacity of communities while developing their skills in the areas of leadership, business, non-profit, cooperative, workforce (career) development, and youth development. Addressing socioeconomic improvement and youth development will be done through collaboration with the College of Business, city governments, NGOs, public and private schools, and municipal entities in Dayton, Columbus, Cincinnati, and Xenia to name a few. The research and studies needed will be done in collaboration by the ARDP and

CSU's CEP. Future initiatives will involve a wider range of community groups and municipalities as greater resources become available and best practices are implemented. The intent of involving these municipalities is to address the need for economic development and attract small business and entrepreneurs to the areas that are served by the planned program. Expanding business opportunities and providing training for stakeholders may create pathways for new jobs, rezoning of underutilized land to create urban farms, and small business opportunities for those with technical knowledge and requisite skills. There are opportunities for rural development, especially with reference to developing agricultural products and manufacturing them in rural areas. CSU CEP's 4-H and youth development programs will address the needs of children, youth, and families at risk (CYFAR). The planned program for the 2020-2025 period will work to deliver the following: a) deliver financial education programs, b) facilitate workshops, c) host and joint sponsor conferences, and d) youth after school, in-school, and summer programs. It is possible that given the wide berth of the current plan, addressing the social and economic issues in this program may affect multiple outcomes in other areas of the Institutional Profile.

vi) Advanced Technologies and Commercialization Systems: The infusion of advanced technologies in agriculture is exploding. Applications of mechatronics that integrates expertise in mechanical engineering, electrical engineering, computer control, machine vision and information technology in a seamless manner in precision agriculture are expanding. Research in mechanical design of new or modifying and adapting agriculture machinery for precision delivery of novel integrated pest management strategies for pest control, coordinated machine control in response to sensory feedback, sensor technology and high level programming will be needed in improving efficiency of farming systems. Integration of technologies related to sensors and actuators, robotics, micro-computers, system simulation and system analysis will be needed in the future. We are planning to develop a nationally recognized research program in precision agriculture in collaboration with the faculty researchers in CESTA. We plan to expand the ongoing research on non-chemical, high energy based pest control conducted by faculty in Agriculture Sciences and Manufacturing Engineering with bringing additional capabilities in mechatronics engineering to develop devices that enhance agricultural efficiency, reduce costs and improve sustainability. We also will develop appropriate services for commercializing the newer technologies so that farming costs are lowered, and economic development is enhanced through newer higher paying jobs in related advanced technology companies.

2. FTE Estimates

Year	1890 Extension	1890 Research
2021	40.0	40.0
2022	45.0	45.0
2023	55.0	55.0
2024	60.0	55.0
2025	60.0	55.0

II. Merit / Peer Review Process

The Merit Review Processes that will be followed are listed as follows:

Internal University Panel External University Panel
 Combined External and Internal University Panel Expert Peer Review

A combined internal, external, and non-university merit review process will be used during this planning period. The Joint Cooperative Extension Program (CEP) and Agricultural Research Development Program (ARDP), the equivalent of an

experimental station at Central State University, will utilize a combined internal and external university and external non-university panel so that we are able to gather important feedback to better address stakeholder demand. Members will be selected every two years to provide a review process of the Joint Extension/Research Plan of Work (POW) to establish the merit of the planned programs. Administrative unit members, specialists, and researchers from both the internal and external land-grant universities will provide input into the plan of work. Additionally, non-university panel members will consist of various partnering agencies with similar types of research and extension priorities in the state will be used to establish the merit of the plan or work. The merit review process will focus on the four planned programs. A comprehensive and detailed program review will be conducted by the panel of the planned programs in the plan of work (POW) at least every other year.

Both CSU's Cooperative Extension and ARDP will utilize advisory committees at different levels to initiate program reviews of all planned programs during the next five years. The reviews will be conducted by panels selected specifically for the purpose of the review. These reviews may consist of peer review of grant applications (small and large) by internal faculty panel, administration, and stakeholders with expertise. Faculty from outside of Central State University Extension (CSUE) and ARDP will be used when needed. Local joint county program reviews conducted by advisory groups at the county level will be used to guide the program and research direction of the planned programs of the POW. Local program reviews will be conducted only where CSUE and ARDP offices establish advisory councils and program committees for merit review and comments on the effectiveness of program impact.

Peer review processes will consist of state program reviews by internal and external extension and research professionals from both land-grant universities of the state. The research program will be reviewed annually by scientific peers.

Stakeholder groups will evaluate the relevance of research priorities, the thoroughness of research procedures in individual projects, project outcomes, publications, and direct and indirect impact of the project on the stakeholders. Internal evaluators will consist of administrators and scientists not directly associated with the planned programs. Expert reviewers and peer review participants will be selected from governmental agencies (state and federal), other universities, and local officials directly related to the commodities or other outputs of the research. Publications by CSUE and ARDP are peer reviewed before publications in print or electronic media. ARDP encourages higher tier peer reviewed journals and tracking citations.

III. Stakeholder Input

1. Actions to Seek

To Seek Stakeholder Input:

Use of media to announce public meetings and listening sessions

Targeted invitation to traditional stakeholder groups

Targeted invitation to non-traditional stakeholder groups

Targeted invitation to traditional stakeholder individuals

Targeted invitation to non-traditional stakeholder individuals

Targeted invitation to selected individuals from general public

Survey of traditional stakeholder groups

Survey of traditional stakeholder individuals

Survey of the general public

Survey specifically with non-traditional groups Survey specifically with non-traditional individuals Survey of selected individuals from the general public

Other (focus groups, public information booths at local gatherings)

To encourage stakeholder input, CSUE and ARDP will use local, regional, and statewide media outlets to solicit involvement and participation. The Extension offices, in cooperation with OSU Extension, will have committees to provide input for program planning, implementation, and evaluation. Local planning committees will be formed in each county

office. CSUE and ARDP are encouraged to recruit, plan and implement public interaction, e.g., town hall meetings, and focus groups sessions. A one-on-one target outreach method will be conducted to gather information and include stakeholders' input. Town Hall meetings and focus group sessions will be held to increase awareness of our mission

2. Methods to Identify

Methods Used to Identify Groups and Individuals to Collect Input:

Use of Advisory Committees Use of Internal Focus Groups Use of External Focus Groups Open Listening Sessions
Needs Assessments

Use of Surveys

Other (1-on-1's with existing and stakeholder)

Multiple approaches will be used for the 2021-2025 planning period to seek stakeholder input. The approaches include formal surveys, focus groups, key informant approaches, advisory councils (collaborating groups, agencies, and organizations) and combinations of the preceding methods. Efforts will be made to ensure that the stakeholders involved will include representatives of the limited resources households in terms of geographic location, family status, income level, age, gender, disability status, and users or non-users of existing educational programs. Guideline manuals will be designed for collecting data from stakeholders and ensuring accomplishment of program priority goals.

Advisory Councils will assist Agents/Educators with identifying and engaging local advisory councils to gather information about the needs and issues in local counties. The Extension Advisory Council will provide recommendations and identify issues for educational programming. The Research Advisory committee will include researchers from USDA and State agencies, business representation and commodity groups. The Town Hall meetings will be implemented to identify issues or needs of citizens in cities targeting the public. Open listening sessions and needs assessments will be conducted jointly between Research and Extension personnel. A series of focus group sessions will be implemented to further prioritize issues identified in public hearings (e.g., town hall meetings).

3. Methods to Collect

Methods for Collecting Stakeholder Input:

Meeting with traditional stakeholder groups Survey of traditional stakeholder groups Meeting with traditional stakeholder individuals Survey of traditional stakeholder individuals
Meeting with the general public (open meeting advertised to all) Survey of the general public
Meeting specifically with non-traditional groups Survey specifically with non-traditional groups Meeting specifically with non-traditional individuals Survey specifically with non-traditional individuals
Meeting with invited selected individuals from the general public
Survey of selected individuals from the general public
Other (focus groups interviews, qualitative data)

Multiple methods will be used for collecting stakeholder input. Town Hall Meetings, surveys, face-to-face, focus groups, one-on-one interactions, and listening sessions will all be used to provide a means of collecting data for stakeholder input. In addition, internal faculty and staff committees, advisory committees, and groups will be able to collect stakeholder input. As we build partnerships with federal, state, and local governments and agencies, we will seek input. Informal, one-on-one, small group interactions, and Extension and Advisory Councils will be the dominant means of garnering input.

4. How Considered

How Collected Input Considered

In the Budget Process
To Identify Emerging Issues

Redirect Extension Programs
Redirect Research Programs
In the Staff Hiring Process
In the Action Plans
To Set Priorities

Stakeholders' input is crucial in building relevant research and extension programs. The stakeholder input process is essential to refocusing and reaffirming priorities on an on-going basis. The stakeholders' input will help research and extension be adaptive to society's needs. The process is also critical in identifying emerging issues. The stakeholder input will contribute to how business is conducted at all levels of the research and extension. This will constantly cause CSU to shift direction in staffing arrangements and budgetary considerations based on the greatest need of the population. Inputs will be gathered and used to establish action plans and to set priorities.

IV. Critical Issues

1 Plant Systems

Description:

Natural Products and Alternative Crops: Issues to be addressed under plant systems include Establishment of Alternate Crops, Increase Use of Natural Products, Modification of Plant Chemistry, Development of Rapid Metabolite Quantification Systems, and Natural Plant Products Research growers in Ohio and across the US face low crop prices and struggle to keep their farms solvent. The overproduction of major grain crops (corn, soybeans, and wheat) by US farmers suppresses commodity prices. Alternative crops are needed to provide growers new revenue streams. Moreover, large-scale adoption of alternative crops can reduce overproduction of major crops, thereby increasing commodity prices. Hemp, Cannabis sativa with a Δ^9 -tetrahydrocannabinol (THC) content less than 0.3%, can be utilized as a food, fiber, feed, bioenergy, and medicine. It is first necessary to explore and develop natural products from plants to provide knowledge and help establish valuable niche markets for alternative and specialty crops. Interesting candidates for Ohio include amaranth, sweet potato, high-amylose corn, tree fruit and nut crops, medicinal plants, hemp, and hops. High-amylose corn is of interest. Corn is one of the most diverse grain crops whereby many variations exist through evolution and extensive breeding efforts. The special variety known as high-amylose corn, has amylose content in the starch and is above normal levels. Recent developments have increased the status of high-amylose corn, particularly the concentration on bioplastics and the search by food companies for a starch type that resists digestion. As a food ingredient, consumers could benefit from high-amylose starch because it has a lower glycemic index than other starches. In addition, plant systems research and extension activities will include hydroponic and aquaponic production and season extension.

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts
Sustainable Agricultural Production Systems

2 Animal Systems

Description:

Avian Systems: Ohio is one of the largest egg farming states in the Nation. CSU CEP avian veterinarian will serve the poultry producers through performance of appropriate examinations, interpret history and laboratory tests, and visit farms, hatcheries, processing plants and other avian enterprises to diagnose, report and

formulate prevention and control plans for spontaneously occurring diseases of poultry and a variety of other avian species. Small Animal/Fish Systems Research Program: One of the long-term goals of the University is to re-establish an animal science research program. CSU has already invested in aquaponics research and extension programs that involves training and technical assistance of limited-resource and small farms in rural and urban areas. Additionally, CSU CEP is seeking farmer-partners and partners from other 1890 and 1862 Land Grants to develop an Extension-based comprehensive educational program for forage-based ruminant production systems (e.g., grass-fed beef/goat production). CSU CEP will start an apiculture (beekeeping) apprenticeship program. Of particular focus will be clients who are military veterans because beekeeping has shown to have salubrious effects on those that have suffered various form of trauma. CSU CEP educators are being trained by CSU apiculture scientist Dr. Hong Mei Li-Byarlay, on various aspects of managing beehives. This apprenticeship will include hands-on trainings, workshops, as well as technical assistance to beekeepers. To support this mission, CSU CEP will be purchasing hive management and honey harvesting tools that will be kept in trailers for our clients to borrow. The beekeeping apprenticeship program should increase bee populations across the state, causing an increase in its associated benefits, and diversify farm income for beekeepers. The descriptions of CSU Bee research programs are given under

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts

Food Safety

Sustainable Agricultural Production Systems

3 Food Nutrition and Health Systems

Description:

CSU's Family and Consumer Science (FCS/EFNEP program will continue to partner with CSU's Food and Nutrition and Health Systems researchers to provide up to date research-based information to our stakeholders. CSU will continue to provide Diabetes Empowerment Education Program to our minority, socially disadvantaged, and economically depressed stakeholders, hold demonstrations in incorporating more vegetables and fruits in their diets, and provide exercise options that can be done at home with no specialized equipment. A mobile kitchen will be obtained and taken to our service counties for cooking demonstrations and education. A nutritionist would work one-on-one with clients requiring nutritional plans. It will also be useful in 4-H programs where school kitchens cannot be used to provide education on human nutrition and learn cooking skills. A Health Education Mobile Unit (HEMU) will be purchased for educators to reach these communities to provide programs. The use of the HEMU will be coordinated with county health departments so that their medical staff could accompany CSU staff. It will include educational and spaces to perform health checks and other medical procedures. In response to the COVID-19 pandemic in low-income communities in Ohio, CSU will continue to provide education related to hygiene practices that mitigate the spread of pandemic, food safety plans for farmers, and provide vaccination education in our communities of service. The HEMU will allow county health department professionals who could bring additional vaccination resources to communities of poverty. In addition, the 4-H and programs will partner to jointly train children, youth, and families at risk about healthy eating on a budget, inexpensive production of produce for at-home consumption, and provide opportunities.

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts

Family & Consumer Sciences

Food Safety

Human Nutrition

Youth Development

4 Natural Resources and Environmental Systems

Description:

Pollinator Issues: Honeybees are the most important managed pollinators contributing \$15 billion for the U.S. economy, but the honeybee colonies are in a 40-50% decline in the country. In particular, managed bee colonies are in a 60% annual decline in Ohio. Promoting mite resistant bees is one of the most effective ways to mitigate the bee decline. It is imperative that we develop new methods for increasing genetic diversity and to improve queen bee quality. The limiting factors affecting local honeybee resources include fewer queens and the nuclei available to fulfill the demand of beekeepers in the region. Water Resources and Water Quality: Water issues in the US are related to 1) variability in availability of the resource for agriculture, domestic industrial and commercial uses, firefighting and recreation; 2) floods and droughts; 3) water quality in agricultural and urban areas; 4) economics of water resources and 5) ways for energy generation. The major phenomenon of change in climate impacts all aspects of water, which requires planning structural and non-structural measures. A major water issue in Ohio is related to water quality. Nitrogen and Phosphorus in agricultural runoff and leaching continues to be a non-point source pollution affecting water quality in Ohio watersheds by causing harmful algal blooms. Soil Health: An assessment of soil information and health at local, regional and global scales will provide a holistic system-based approach to address the issues at the nexus of plant, animal, natural resources and environmental systems. Agricultural Ecology: Biodiversity and saving endangered species are important for improving the ecosystems in farming areas. Organic farming has numerous benefits in improving the ecosystems.

Term: Long

Science Emphasis Areas

Agroclimate Science
Bioeconomy, Bioenergy, and Bioproducts
Environmental Systems
Sustainable Agricultural Production Systems

5 Engaging Communities and Transforming Lives**Description:**

Improving the overall conditions facing individuals and families in Ohio's communities, as well as addressing agricultural issues in rural, urban, and Appalachia locations will be aimed. Building Families and Communities- Family Consumer Sciences: Issues include childhood obesity, family resilience, financial readiness, health, hunger, and environmental degradation. Addressing these through research and programming focused on human nutrition, food and non- food products, food safety, hospitality/recreation, health, and financial education are planned. Creating Youth Pathways to Success: The 4-H and Youth Development program currently addresses societal needs by providing strong and resilient individuals, families, and communities in Ohio. Developing Better Socio-Economic and Sustainable Communities: The Community and Economic Development programs seek to empower communities to achieve their goals through education and technical assistance. This will be achieved through offering high school equivalency education, criminal record expungement program, and local and micro entrepreneurship and jobs programs. Also, we offer technical assistance to Ohioans through training clients in governmental disaster relief programs and assisting with completing applications to obtain disaster relief. Improving Agriculture, Sustainability and Economics - Agriculture and Natural Resources (ANR): This links our Land-Grant research and extension efforts by providing education to Ohioans through conferences, seminars, workshops, field demonstrations, and farm tours. The ANR will be involved in farmer training, dissemination of research results from CSU's ARDP program, providing technical support for agricultural and forestry operations.

Term: Long

Science Emphasis Areas

Education and Multicultural Alliances
Family & Consumer Sciences
Human Nutrition

6 Supporting small and medium-sized farms

Description:

Ohio small and medium-sized farms are afflicted with production risk, fluctuating prices, and shrinking access to labor. To facilitate the survival of these farms, Central State University will conduct research and extension activities related to plant systems associated with the establishment of alternate crops, increase use of natural products, modification of plant chemistry, development of rapid metabolite quantification systems, and natural plant products. Alternative crops considered include hemp, Cannabis sativa with a THC content less than 0.3%, amaranth, sweet potato, high-amylose corn, tree fruit and nut crops, medicinal plants, and hops. High-amylose corn is of interest to consumers who want to lower the starch-based calories in their diet due to its lower glycemic index than other starches. We will also focus on small and medium-scale hydroponic and other soilless culture systems that can grow plants intensively, requiring no tillage and harvesting equipment, and needing a modicum of labor. Furthermore, CSU CEP will provide education and technical assistance to small and medium-sized farms and farm families in production management issues (such as IPM, pesticide use), financial management issues, entrepreneurship, and food-nutrition issues. ARDP is proposing to conduct research in using advanced technologies to assist small and medium scale farmers and expand its capabilities to assist farmers in organic farming and engage in farming alternate crops to improve farm income. CSU CEP will address the needs of farms facing barriers to land access, financing, and labor, by developing beekeeping apprenticeships. Since a beekeeping operation requires little land and low levels of financing and labor, and results in highly marketable honey and beeswax products, it is an ideal crop for limited resource farms. These apprenticeships will occur statewide with hands-on trainings and technical assistance by Extension educators.

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts
Sustainable Agricultural Production Systems

7 Building new farmers, supporting limited-resource and urban farms

Description:

As an 1890 Land Grant university, CSU is dedicated to educating and assisting limited-resource farms and urban farms. Part of this effort will include the training of prospective/beginning farmers recruited among traditionally underserved communities, including urban communities. Soil less production systems such as aquaponics and hydroponics will be used in fulfilling this critical issue by conducting research and holding extension demonstrations at incubator farms in rural, urban, and peri-urban regions of Ohio. The incubator farms will be selected through networking with existing farms, governmental agencies, and community-based organizations.

CSU will continue to develop research objective related to beekeeping, aquaponics, and small animal production that are congruous with the limitations of land, capital, and labor that typify these farms. Their findings will guide extension demonstrations and farmer training. Extension programs in Community and Economic Development will provide training in entrepreneurship and business development, while Family and Consumer Sciences will educate farm families about the judicious selection of food for good nutrition, improving relations within a farm family and stress management, and on personal family finances. If CSU reestablishes an animal science research program, priority will be given in production systems that have demonstrated marketing avenues which lead to farm-level profits.

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts
Sustainable Agricultural Production Systems

8 Promoting food nutrition and health for socially-disadvantaged communities

Description:

The welfare of socially disadvantaged communities is a critical priority for 1890 Land-Grant programs, including CSU. Socially disadvantaged people are often at a greater risk of poor nutrition and illness, including diabetes, than more affluent populations. The United States spends \$200 billion in healthcare related to obesity, and more than 81 million Americans are completely inactive and lack physical activity. Ohio has the 11th highest adult obesity rate in the nation, and the sixth highest obesity rate for youth ages 10 to 17.

CSU will engage in research and extension activities that are related to human nutrition and exercise education, as well as food delivery systems to underserved populations to target treatments are necessary. Research results will help determine the best practices in health promotion. These endeavors will be based on nutrigenomics knowledge, which could lead to personalized nutrition plans. Research into relaxation techniques using Yoga and integrate the nutrigenomics with the use of herbs can also benefit our target audience. Obesity in children is a growing epidemic in the United States, and the minority populations are especially at risk for obesity. As part of the research program, physiologic parameters including resting heart rate, blood pressure and body composition will need to be assessed before and after the intervention.

CSU CEP will play a critical role in the dissemination of research results pertaining to human nutrition and health. To assist Family and Consumer Science staff to bring programs over all 60 service counties, CSU will purchase a Health Education Mobile Unit (HEMU) that will also accommodate county health department medical staff who could augment CSU CEP health programs with additional education, health screenings, and other medical services.

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts

Family & Consumer Sciences

Food Safety

Human Nutrition

Youth Development

9 Preparing youth, for STEM careers, leadership, resiliency and finances

Description:

CSU is focused on providing a holistic approach to improve the overall conditions facing individuals and families in Ohio's communities, as well as addressing agricultural issues in rural, urban, and Appalachia locations.

Building Families and Communities: CSU's Family Consumer Sciences program will provide training to families and communities on specific issues like childhood obesity, family resilience, risk management, financial readiness, health, hunger, and environmental degradation. Addressing these issues through scientific research and programming focused on human nutrition, food and non- food products, food safety, hospitality/recreation, health, and financial education are essential plans of action. **Creating Youth Pathways to Success:** CSU's 4-H Youth Development program currently addresses societal needs by providing strong and resilient individuals, families, and communities in Ohio. Specifically, youth are receiving hands-on education on STEM topics and on agriculture. Additionally, youth will learn water science based careers through collaborations with International Center for Water Resources Management. This programming will continue in future, with emphasis on schools with a significant population of at risk youth. In addition to STEM topics, youth will learn leadership, business skills, environmental knowledge, agriculture, human nutrition, and exercise science. **Developing Better Socio-Economic and Sustainable Communities:** CSU CEP's Community and Economic Development program seek to empower communities to achieve their goals through education and technical assistance. The aims of this program are community development and revitalization, leadership development, local economic development, entrepreneurship and small business development, and government programs and disaster preparedness and assistance.

Term: Long

Science Emphasis Areas

Education and Multicultural Alliances
Sustainable Agricultural Production Systems
Youth Development

10 Advanced Technologies and Commercialization Systems.**Description:**

The infusion of advanced technologies in agriculture is exploding. Applications of mechatronics that integrates expertise in mechanical engineering, electrical engineering, computer control, machine vision and information technology in a seamless manner in precision agriculture are expanding. Research in mechanical design of new or modifying and adapting agriculture machinery for precision delivery of novel integrated pest management strategies for pest control, coordinated machine control in response to sensory feedback, sensor technology and high level programming will be needed in improving efficiency of farming systems. Integration of technologies related to sensors and actuators, robotics, micro-computers, system simulation and system analysis will be needed in the future. We are planning to develop a nationally recognized research program in precision agriculture in collaboration with the faculty researchers in CESTA. We plan to expand the ongoing research on non-chemical, high energy based pest control conducted by faculty in Agriculture Sciences and Manufacturing Engineering with bringing additional capabilities in mechatronics engineering to develop devices that enhance agricultural efficiency, reduce costs and improve sustainability. We also will develop appropriate services for commercializing the newer technologies so that farming costs are lowered and economic development is enhanced through newer higher paying jobs in related advanced technology companies.

Term: Long

Science Emphasis Areas

Bioeconomy, Bioenergy, and Bioproducts
Environmental Systems
Food Safety
Sustainable Agricultural Production Systems